

BRITISH COLUMBIA PROVINCIAL MUSEUM
DEPARTMENT OF EDUCATION

HANDBOOK No. 7



THE BARNACLES OF BRITISH COLUMBIA

By IRA E. CORNWALL, F.G.S.

VICTORIA, B.C.

JANUARY, 1955



104-03982/

BRITISH COLUMBIA PROVINCIAL MUSEUM
DEPARTMENT OF EDUCATION

HANDBOOK No. 7

THE BARNACLES OF BRITISH COLUMBIA

By IRA E. CORNWALL, F.G.S.

Illustrations by FRANK L. BEEBE
(except where noted)

JANUARY, 1955



VICTORIA, B.C.

Printed by DON McDIARMID, Printer to the Queen's Most Excellent Majesty
1955

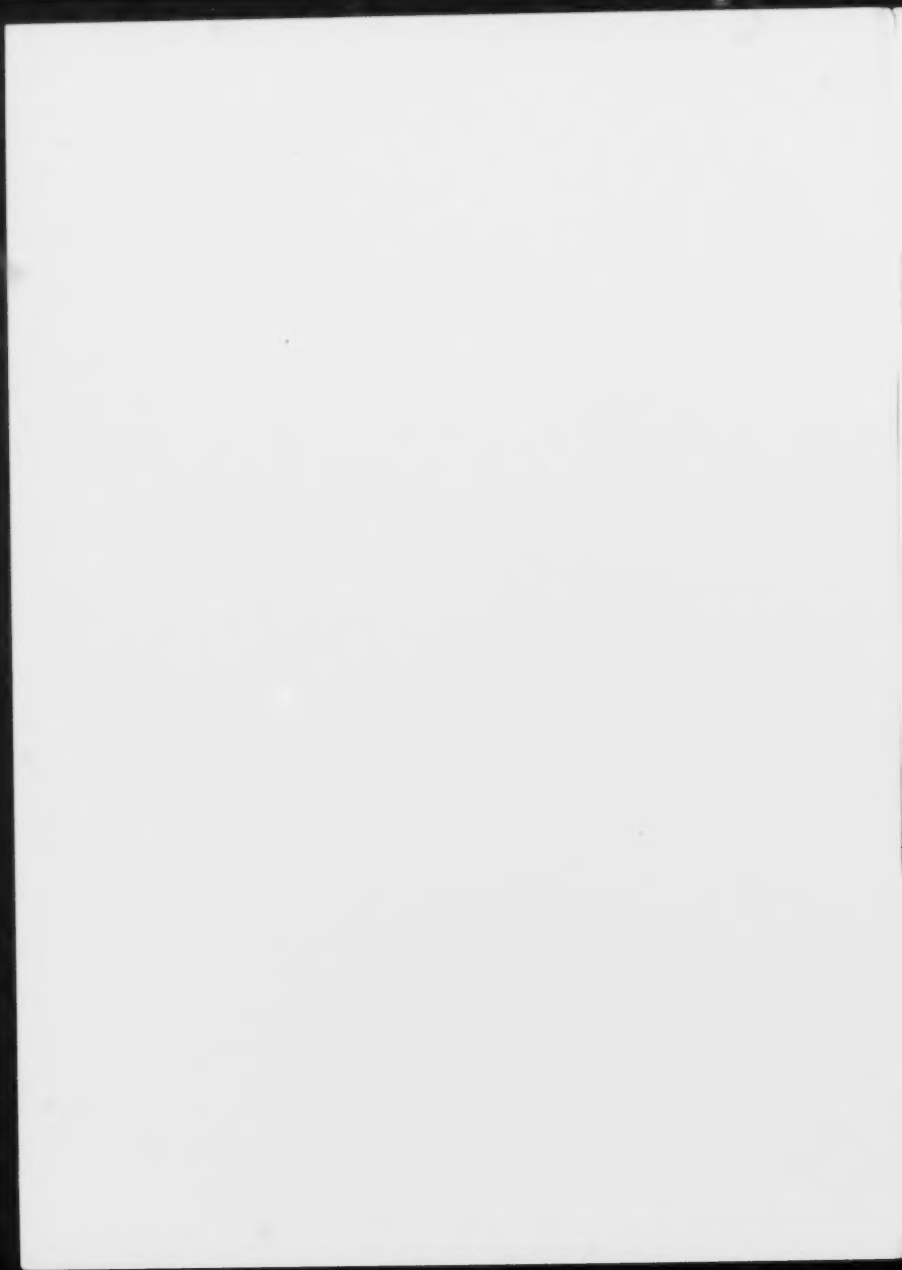


TABLE OF CONTENTS

	PAGE
Introduction	5
Historical Notes	6
Structure of Barnacles	10
Variation in the Shell	14
Economic Importance	16
Life-history	17
Identification of Species	19
Acknowledgment	20
Key to the Acorn Barnacles	21
<i>Balanus cariosus</i>	22
<i>Balanus nubilus</i>	23
<i>Balanus crenatus</i>	25
<i>Balanus glandulus</i>	27
<i>Balanus rostratus alaskensis</i>	29
<i>Balanus engbergi</i>	31
<i>Balanus balanus</i>	32
<i>Balanus hesperius laevidomus</i>	34
<i>Chthamalus dalli</i>	36
Key to the Goose Barnacles	38
<i>Scalpellum columbianum</i>	39
<i>Mitella polymerus</i>	40
<i>Lepas anatifera</i>	42
<i>Lepas hilli</i>	44
<i>Lepas pectinata pacifica</i>	45
<i>Lepas fascicularis</i>	46
Key to the Whale Barnacles	48
<i>Cryptolepas rachianecti</i>	49
<i>Coronula diadema</i>	51
<i>Coronula reginae</i>	54
<i>Xenobalanus globicipitis</i>	56
<i>Conchoderma auritum</i>	58
<i>Conchoderma virgatum</i>	59
Possible Additional Species	60
Glossary	61
Bibliography	67

Except in the case of groups such as "acorn barnacles," "goose barnacles," and "whale barnacles," these creatures do not have common or vernacular names. It is necessary, therefore, to use scientific names for the various species, as is done in this booklet.

It might be well to make clear the manner in which scientific names of plants and animals are shown. This is done in a conventional manner accepted the world over. The name of the genus, in a latinized form, is placed first and has a capital letter; this is followed by the name of the species, also latinized, but beginning with a small letter, thus, *Chthamalus dalli* Pilsbry. Both are printed in italics and are followed by the name of the original describer of the species. If the name of the genus has been changed, as often happens, then the name of the original describer of the species is shown in parentheses, as, for example, *Balanus cariosus* (Pallas).

The first time that a technical term is used in this booklet it is shown in quotation marks, which indicate that a definition will be found in the glossary.

HISTORICAL NOTES

The study of barnacles may be divided into two periods—before Darwin and after Darwin. During the first period considerable interest was taken in them, judging by accounts in old natural-history books. One of the most extraordinary of these expressed the idea that barnacles turn into geese. Gerard's "Herball," published in 1597, gives a good account of this quaint piece of natural history. He tells that "in the North parts of Scotland, and the Ilands adjacent, called Orchades (Orkneys) are found certaine trees whereon doe growe certaine shell fishes, of white colour tending to russet; wherein are contained little living creatures; which shels in time of maturitie doe open, and out of them grow those little living foules whom we call Barnakles, in the North of England Brant Geese, and in Lankashire Tree Geese; but the others that do fall upon the land perish, and come to nothing. Thus much by the writings of others, and also from the mouths of people of these parts, which may very well accord with truth."

Not content with hearsay evidence, however, Gerard writes "what our eies have seene and hands have touched we shall declare." He describes how on the coast of a certain "small ilande in Lancashire called Pile of Foulders" (probably Peel Island) the "wreckage of ships is cast up by the waves, along with the trunks



Fig. 1. Barnacle tree (from Munster's "Cosmography").

and branches of old rotten trees." On this driftwood a "certaine spume or froth grows," according to Gerard. This spume "in time breedeth unto certaine shels in shape like those of the Muskle, but sharper pointed, and of a whitish colour." He continues: "It gapeth open, and the first thing that appeareth is the foresaid lace



The Barnacles of British Columbia

INTRODUCTION

At first sight, barnacles look like slight projections of the rocks on which they grow, but closer inspection will show that each contains a well-developed animal which is wonderfully adapted to its mode of life. There is not just one kind of barnacle, as a casual observer might think, but there are four or five hundred kinds, or species, in the world. Some of them have taken strange places in which to live: one species is found only on the tongue of a certain turtle; another bores holes in soft rock; one species has developed a float; several species are found only in very deep water. Others are found only between high- and low-tide marks, where they grow in such profusion that they appear to be the dominant group of living things in this zone. Still others live mostly embedded in the skin of whales or attached to the tip of the whale's flipper. Others again (e.g., *Saculina*) are wholly parasitic, living upon crabs of several species. These last are degenerate forms, however, and are not included in this booklet.

The question naturally arises: What is a barnacle? Simply answered, a barnacle or cirriped is a crustacean, a relative of the crab, lobster, and sand-flea, that has attached itself permanently to some object larger than itself. A shell has developed in which it lives, and its legs have become modified into most efficient sweeps for the capture of the small sea-creatures and organic material on which it feeds.

If a barnacle is examined, it will be seen that the opening at the summit of the shell is closed by four movable plates hinged like folding doors. When these are opened, the sweep may be protruded; when they are closed, the barnacle is protected from enemies and from drying when exposed to the air. When one walks over the rocks at low tide, a slight grating or bubbling noise may be heard. This is caused by the barnacles closing their doors more tightly, an action which may be induced even by the passing of a shadow.

or string. Next cometh the legs of the Bird hanging out; and as it groweth greater, it openeth the shel by degrees, till at length it is all come forth, and hangeth only by the bill; in short space after it cometh to full maturitie and falleth into the sea, where it gathereth feathers, and groweth to a foule, bigger than a Mallard, and lesser than a goose, having black legs and bill or beake."

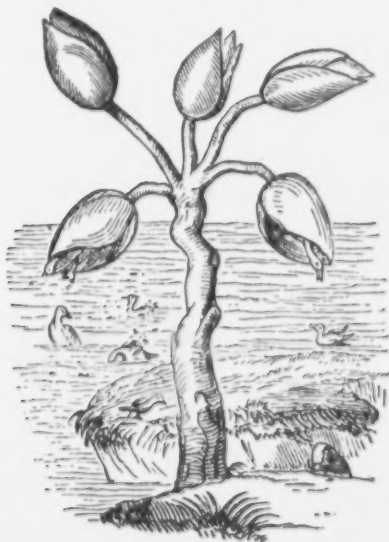


Fig. 2. The barnacle tree (from Gerard's "Herball").

The description states that the geese come out of the shell feet first, but the illustrations in the article show them coming out head first. Figs. 1 and 2 are copies of these illustrations.

Professor MacMuller, after discussing various theories of the origin of the barnacle myth, is in favour of the idea that confusion of language and alteration of names lie at the root of the error. Bernicle geese and barnacle shells become confused and, once started, the ordinary process of growth was sufficient to further

intensify, and render more realistic, the story of the barnacle tree and its wonderful progeny. (See also "The Myth of the Barnacle Goose," by D. B. Quayle, *Victoria Naturalist*, Vol. 9, No. 2, 1952.)

With the publication of Darwin's monographs on the subclass Cirripedia, which appeared in 1852 and 1854, the scientific study of barnacles was placed on a firm foundation. Not only did Darwin describe and classify all the living barnacles that were known at that time, but he also included the fossil barnacles in a classification that has not yet been improved.

According to Darwin, the common "acorn" barnacle probably descended from the "pedunculate" type, as remains of pedunculate barnacles have been found at a much earlier period than those of the acorn barnacles. The first trace of an ancestral form has been found in the Devonian period (marked (1) in the table below). Remains of the pedunculate have been found in the Triassic rocks (2), and the first acorn barnacles appear in the Cretaceous rocks (3) (Withers, 1928).

The following table shows the relative position of these divisions of geological time:—

Recent, or present.

Pleistocene.

Pliocene.

Miocene.

Oligocene.

Eocene.

(3) Cretaceous.

Comanchian.

Jurassic.

(2) Triassic.

Permian.

Pennsylvanian.

Mississippian.

(1) Devonian.

Silurian.

Ordovician.

Cambrian.

Pre-Cambrian.

STRUCTURE OF BARNACLES

There are two great divisions of the barnacles, or "Cirripedia," namely, the acorn, or "sessile," and the goose, or "pedunculate." In both these divisions the internal anatomy is much the same, but their outside appearance is very different. The sessile barnacles have calcareous shells fixed directly to some support, while the pedunculate barnacles have the body-chamber, or "capitulum," on the end of a flexible stem, the "peduncle." The peduncle, in turn, may be anchored to a fixed or to a floating object, or, in one case, to a float produced by the cement gland.

Certain sessile barnacles are to be found on whales, and these are known by the general term "whale barnacle." However, two species of the pedunculate barnacle *Conchoderma* are commonly found attached to certain whale barnacles, and these are often called whale barnacles for convenience.

The number of plates forming the shell of the different genera of sessile barnacles varies from eight in *Catophragmus* (Bermuda, Hawaiian Islands, and New South Wales) to one in *Pyrgoma* (West Indies), in which all the plates are fused together to form a solid ring.

On the British Columbia coast there are only two genera of sessile barnacles—*Balanus* and *Chthamalus*. They each have six triangular plates forming the conical shell, but the arrangement of the plates differs, as shown in Fig. 3.

In some sessile barnacles the plates forming the wall are solid. In others they are double, being formed by the inner and outer "lamina," the space between them being filled by the "parietal" tubes. These tubes run from the "basal" part of the plates to the "apex," and in several species they have "cross septa" dividing the tubes into a series of cells.

The "base" or "basis" is the part of the shell that is attached to its support, really the floor of the shell. Only one British Columbia species (*Balanus cariosus*) has a membranous base, consisting of a simple membrane made up of concentric rings that are added to the periphery at each period of growth. All the other species of this coast have calcareous bases. Some are very thin, and will adhere to their support firmly. In collecting, it will often

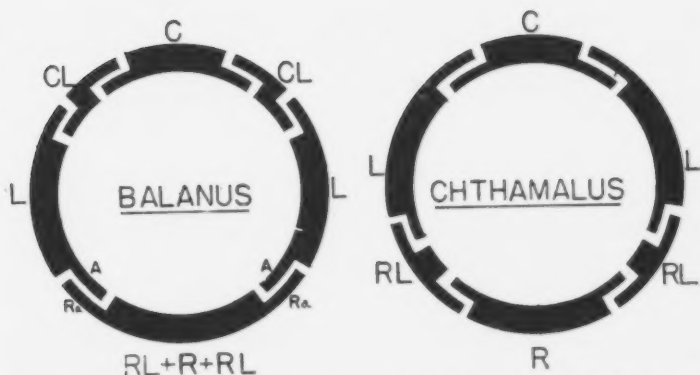


Fig. 3. Arrangement of the plates forming the shell of *Balanus* and *Chthamalus*, shown diagrammatically. C, carina; CL, carinolateral; L, lateral; RL, rostrrolateral; R, rostrum. In *Balanus* the two rostrrolaterals are coalesced with the rostrum to form one plate, RL+R+RL in the figure. Ra is the radius, the part of each plate that overlaps the next plate. A is the ala, which lies under the radius. (Cornwall.)

be found that the shell will break around the lower edge, thus leaving the base attached to the support. The bases of some barnacles, such as *Balanus nubilus*, are very thick and are permeated by pores similar to the parietal tubes in the walls.

The thickened part of the shell around the interior of the "orifice" is called the "sheath." It is composed of fine shelly layers which become deeper as the shell grows. Attached to the sheath a little above its lower margin is the "opercular membrane," which acts as a cover for the orifice. An opening in the centre permits the "cirri" to be protruded during times of feeding. On each side of the opening are two pairs of calcareous cover-plates named the "scuta" and "terga."

Within the shell the body is enclosed in a "mantle," a membranous organ which secretes the limy material of which the shell is made (see Fig. 4). The animal lies on its back with the cirri pointing up directly under the opening of the operculum, through which they are thrust when in search of food. The cirri are com-

posed of six pairs of legs; each leg has two branches made up of many segments, and each segment has a double row of spines on the inner face forming a very efficient net. Food is carried directly to the mouth, which is situated on a prominence near the middle of the body.

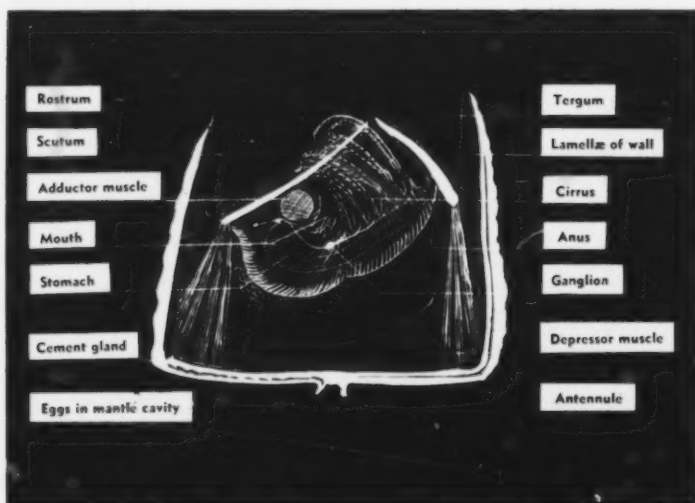


Fig. 4. Diagrammatic section through an acorn barnacle to show the major parts.

The barnacle has no heart or circulating system as found in the higher animals. Body fluids flow through passages among the muscles and other organs in a "lucunar" circulation.

Barnacles have a well-developed nervous system, that of the pedunculate species being arranged in a ladder-like manner very similar to that of the primitive crustaceans, from which barnacles undoubtedly were derived (Cornwall, 1953). In the sessile barnacles the nervous system is much more centralized, the ladder-like arrangement being concentrated into one large "ganglion," from which the nerves to the appendages radiate (Fig. 5).

Simple eyes are present beneath the skin of the "prosoma," the bag-like portion of the body which corresponds to the head. The eyes are sensitive to light; the shadow of a hand passing over barnacles in a tide pool will cause them to close their cover-plates.

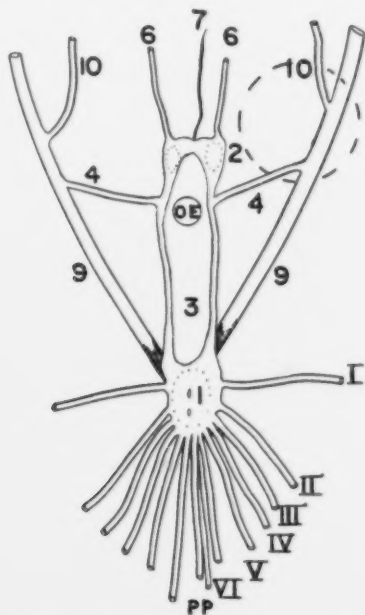


Fig. 5. Nervous system of *Balanus nubilus*. 1, Infra-oesophageal ganglion; 2, supra-oesophageal ganglion; 3, nerve chord around the oesophagus (OE); 4, nerves leading to the muscle that closes the cover-plates; 6, nerves leading to the network of nerves that are near the surface of the body; 7, optic nerve, leading to the eyes; 9, splanchnic nerves to the viscera; 10, branch to cover-plate muscles; I to VI, nerves leading to the cirri; PP, nerves leading to the penis. (Cornwall, 1953.)

The body-chamber or capitulum of pedunculate barnacles is protected by a series of calcareous plates. In *Lepas* there are five such plates—paired scuta and terga and a single "carina," cor-

responding to the cover-plates in sessile forms. Additional lateral plates or rows of scales may be present in members of other genera, and scales may also be present on the peduncle.

In some species the peduncle is provided with three layers of muscles—longitudinal, transverse, and oblique—that give it the power of motion. Several cement glands at the base of the peduncle fasten the animal to its support.

At intervals throughout life a barnacle casts off its old skin and replaces it with a larger one to allow for growth. In the larval stages this moulting takes place several times, sometimes in rapid succession; in the adult stage it is less frequent, the intervals of time depending upon the rate of growth. In the process the entire chitinous covering of the body, together with the covering of the branched cirri and other appendages, is cast off in one piece, as is the case with other members of this class.

For some unknown reason, moulting seems to take place simultaneously over a large area; many moults are often to be seen at one time floating in the sea.

VARIATION IN THE SHELL

The shell of the barnacle is beautifully designed for the protection of the enclosed body, and yet exhibits an almost unlimited range of variation, which makes the determination of the species very difficult. It cannot be too strongly impressed on anyone intending to study this group not to rely on external characters. Even after long experience with barnacles from all parts of the world, an expert may have difficulty in naming several species common to this coast without dissecting them.

There is one species common on the coast of British Columbia that would certainly be divided into several species if judged from external appearance alone. This is *Balanus cariosus* (Fig. 6), the barnacle that is found in great numbers between high- and low-tide marks. Occasionally an individual will be found growing alone and uncrowded; under such conditions the shell will assume its normal shape, a steep-walled cone with a jagged irregular opening at the top. The walls are covered with many downward-pointing spines, giving what Darwin called a "thatched appear-

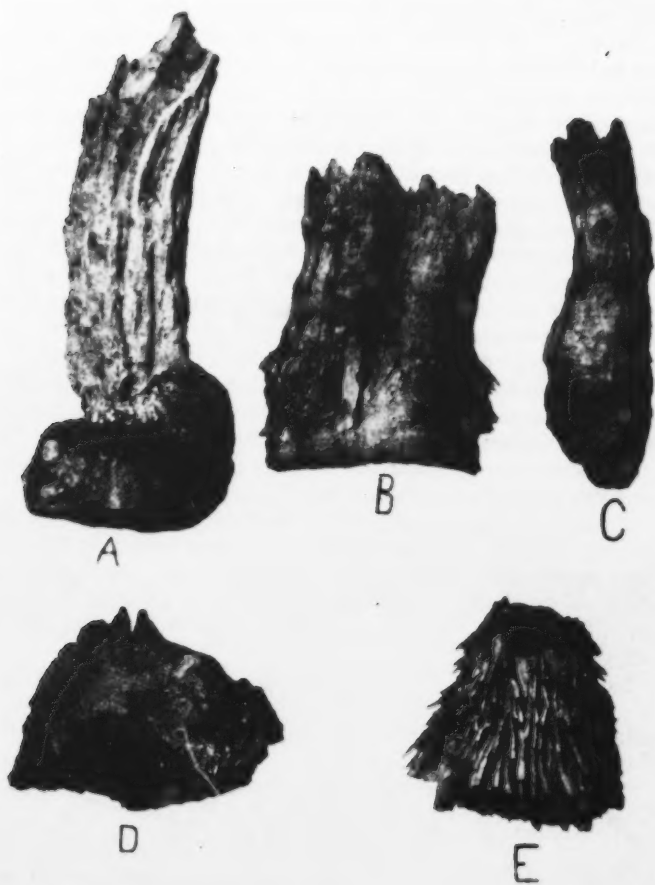


Fig. 6. Variations in the shell of *Balanus cariosus*. A, an individual on a restricted surface; B and C, individuals showing the effects of crowding; D, an individual exposed to erosion; E, a "normal," uncrowded individual. (Cornwall, 1925.)

ance," as shown in E of Fig. 6. The walls are thick, and are permeated by many pores. When crowded, this barnacle assumes quite a different form, as the plates forming the wall are then much elongated and show no trace of the thatched appearance. This form is shown in B and C. When the barnacle grows on a restricted surface, such as a pebble, it takes the form shown in A, in which the walls are thick and rough and may or may not have the thatched appearance. When this species grows on a rock where it is exposed to erosion caused by wave-action and water-borne materials, it looks quite different again. The walls coalesce, and are worn down nearly as fast as they grow. The cover-plates, however, are not eroded, as they are not firmly fixed as the walls are. As a consequence, they often tend to project above the level of the walls (Fig. 6, D).

The largest barnacle found on this coast, *Balanus nubilus*, gains room, when crowded, by deepening its base, which often becomes a cornucopia-shaped cup that may reach a length of 6 inches. The shell does not vary in shape, but its external sculpturing can rarely be seen as it is usually much eroded.

Erosion, or wearing away of the shell, is worthy of note in the study of barnacles, since some species are very subject to it, while others seem to have developed an immunity to it. For example, a full-grown specimen of *Balanus nubilus* or *B. cariosus* is rarely seen without some evidence of erosion, while *B. rostratus* almost always has a perfect shell.

Since Darwin in his monograph on the Cirripedia goes into the subject of variation at considerable length, there is no need to consider the subject further here, except to conclude with the following paragraph from this work:—

"Not only does every external character vary greatly in most species, but the internal parts very often vary to a surprising degree; and to add to the difficulty, groups of specimens not rarely vary in the same manner."

ECONOMIC IMPORTANCE

The attachment of marine organisms such as barnacles and sea-weed to the bottom of a ship is a very serious matter, as the immense amount of growth of this type slows the ship greatly.

Moreover, the periodic removal of barnacles from hulls and the consequent repainting are operations which add greatly to the cost of upkeep. Barnacles, therefore, are considered to be a serious pest in marine circles.

On the other hand, however, the young, which are free-swimming for some time after they are hatched, are eaten in large quantities by various species of fish. During one season the writer caught a few young herring every day until they left for deep water and examined the contents of their stomachs. In every one there were some young barnacles. Barnacle larvæ may therefore form a very important source of food for fishes of commercial importance.

The peduncle of the barnacle, *Mitella polymerus*, found at about half-tide mark where it is well washed by the waves, makes an acceptable food item when steamed about twenty minutes in the Indian fashion. Some of the larger acorn barnacles such as *Balanus nubilus* also make very good eating, especially when they contain large quantities of eggs.

In Japan large quantities of barnacles are gathered for use as fertilizer.

LIFE-HISTORY

One of the most interesting aspects in the study of barnacles is their method of reproduction. They are "hermaphrodites"; that is, both male and female reproductive organs are present in each individual. However, members of some genera, such as *Ibla* (Philippine Islands and Australia) and *Scalpellum* (world-wide) have what is called a "complemental male," which bears about the same size proportion to the barnacle as a mouse does to a man. By some means this little creature gets into a small pocket, or cavity, near the edge of one of the cover-plates. The complemental males vary greatly in structure; some are without mouth or stomach and have no means of capturing food, therefore they must be very short lived. Others have cirri and capture food in the same manner as the larger partner in which they live.

In all species the eggs are retained in two sacs, called the "ovigerous lamellæ," in which they are held together in layers by a delicate transparent membrane. When the young first emerge

from the egg, they are in the "nauplius" or free-swimming stage. For some unknown reason, all the barnacles of one species, in a large area, will produce young at the same time. At certain seasons of the year these young may be seen drifting like clouds through the sea. Since barnacles produce a large number of eggs, a vast number of larvæ may be present in these areas.

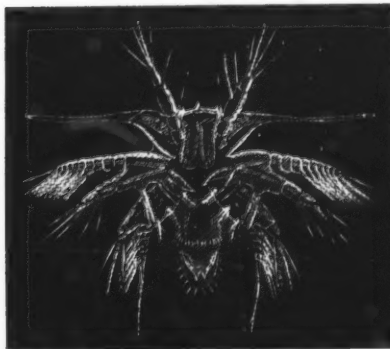


Fig. 7. The metanauplius stage of a barnacle.



Fig. 8. The cypris stage of a barnacle. (From a text.)

The larvæ increase in size by a series of "moult" until they reach the "metanauplius" stage, during which they change in form (Fig. 7) and the single eye becomes two. By the end of the next moult a bivalve shell has developed (Fig. 8), additional appendages appear, and globules of fat form in the body to provide buoyancy. After a period of some days this "cypris" larva settles on a solid object to which it becomes attached by the "antennules" assisted by secretions from the cement glands. The bivalve shell is now lost, the body becomes greatly changed in form, and the valves of the adult shell appear. For the rest of its life the barnacle remains fixed in this position literally "standing on its head and kicking food into its mouth with its feet."

The life-history of many species of barnacles is little known; great opportunities for research in this field are open to anyone

interested in this phase of marine biology. This is particularly true in the case of whale barnacles, about which almost nothing is known.

IDENTIFICATION OF SPECIES

It is easy to tell at sight to which of the two great groups a barnacle belongs. If it has a more or less flexible stem, it is a pedunculate barnacle. If the shell is attached to a support in such a way that it cannot move, it is a sessile or acorn barnacle. Whale barnacles are acorn barnacles specially modified for attachment to whales.

The pedunculate species found on the coast of British Columbia are divided among four genera. They are readily identified by use of the key and reference to the figures and accompanying text.

It is a little more difficult to identify an acorn or sessile barnacle as the outside appearance alone is not a reliable guide, as previously noted. However, the internal sculpture of the cover-plates appears to be fairly constant and can be used in the identification of most species. For examination they should be removed and boiled for a few minutes in a strong solution of sodium hydroxide, after which they should be washed and dried. It is advisable to glue them on a slip of pasteboard, arranging them so that one pair of cover-plates shows the inside and one the outside.

However, it is not safe to rely alone on the sculpture of the cover-plates for identification as there are species with plates that look nearly the same. Therefore, several other characters must be taken into consideration: The number of spines on the middle segment of the sixth leg; the shape of the mouth parts; and the structure of the base of the shell.

An examination of the mouth parts must be done if a correct determination of the species is required, and this is rather difficult to do if the specimen is a small one like *Chthamalus*. Since in some of these a full-grown specimen is only 4 or 5 millimetres in diameter, the mouth parts can be seen only under a magnifying-glass.

The following is an old and well-tried method of dissecting such structures as the mouth parts of a small barnacle. The portion to be dissected is passed through 50, 70, and 95 per cent

alcohol, and then transferred to a drop of cedar-oil on the microscope slide on which the parts are to be mounted. It may take from six to twenty-four hours for the object to sink into the cedar-oil and to become cleared ready for dissection.

Since these small details of structure are not given in the descriptions to follow, the more serious student is referred to publications listed in the bibliography for this material.

In the study of barnacles it would be well to have a clear understanding of the position in which a barnacle is always shown. The creature is fastened to its shell by its back; this brings the "ventral" part up with the legs (cirri) toward the observer.

ACKNOWLEDGMENT

The writer is pleased to make use of this opportunity to thank those who have helped get together the information about the barnacles of the British Columbia coast: Dr. G. Clifford Carl, of the Provincial Museum, for editing the manuscript; Mr. Frank Beebe for the illustrations; Dr. J. L. Hart, of the Pacific Biological Station, Nanaimo, and Dr. Arthur Martin, of the Department of Zoology, University of Washington, Seattle, for loan of specimens; Mr. Gordon C. Pike, of the Pacific Biological Station, for valuable material on the whale barnacles; and others who have assisted in many ways.

He is especially grateful to Dr. H. A. Pilsbry, of the Philadelphia Academy of Sciences, and also to the late Dr. T. H. Withers, of the British Museum.

KEY TO THE SPECIES OF ACORN BARNACLES KNOWN
TO OCCUR REGULARLY IN BRITISH COLUMBIA

- 1 (16) Rostrolaterals of shell fused to rostrum to form one plate;
spaces between cover-plates not in form of cross.
Genus Balanus.
- 2 (15) Base calcareous; wall with no downward-pointing spines.
- 3 (6) No tubes in wall.
- 4 (5) Wall rough and strongly ribbed; orifice oval.
Balanus engbergi.
- 5 (4) Wall smooth and white; orifice square.
Balanus hesperius.
- 6 (3) Tubes in wall.
- 7 (10) No cross-septa in tubes.
- 8 (9) Interior of cover-plates white; base solid with radial
grooves.
Balanus balanus.
- 9 (8) Interior of cover-plates buff; base irregularly porous.
Balanus nubilus.
- 10 (7) Cross-septa in tubes (visible only when powder is
removed).
- 11 (14) Tubes hollow.
- 12 (13) Cross-septa in upper part only; wall smooth and white.
Balanus crenatus.
- 13 (12) Cross-septa from base to apex, tubes large and square;
epidermis brown.
Balanus rostratus.
- 14 (11) Tubes filled with white powder; lining of cover-plates
black.
Balanus glandulus.
- 15 (2) Base membranous; wall with downward-pointing spines.
Balanus cariosus.
- 16 (1) Rostrolaterals not fused to rostrum; spaces between
cover-plates in form of a cross.
Chthamalus dalli.



Balanus cariosus (Pallas).

Description.—The size varies greatly up to $1\frac{1}{4}$ inches in diameter and $2\frac{1}{2}$ inches in height. The normal shell is a steep-walled cone with numerous downward-pointing spines, giving it a "thatched" appearance. When crowded they take on a tubular form and may lack the spines (for variations see Fig. 6). The base is membranous.

Colour, white in young or uncrowded individuals; otherwise dirty grey.

Distribution.—Coasts of Western North America and Japan. At about the quarter-tide level, on rock.

Notes.—On the British Columbia coast this is the only large barnacle with a membranous base. It is usually found on the rocks, and much crowded.

References.—Darwin, 1854, p. 273; Pilsbry, 1916, p. 189; Cornwall, 1925, p. 472; Henry, 1942, p. 102.



Balanus nubilus Darwin.

Description.—The normal-shaped shell may be 2 or 3 inches in diameter and 4 to 5 inches in height. The opercular opening is large and has a jagged edge. The beak of the tergum projects above the edge of the opening. Well-developed ribs are present in young specimens, but they tend to become obscured by erosion in older individuals. The base is calcareous and porous.

Colour, dirty white with pink parietes in some young specimens. Cinnamon buff on the interior of the cover-plates; a purple patch usually near the beak of the tergum.

Distribution.—Southern coast of Alaska south to Monterey Bay, California.

Below low-tide level, usually in 10 to 20 feet of water; occasionally down to 30 fathoms.

Notes.—This is the largest barnacle found on the Pacific Coast of North America. It is often found in large groups of individuals growing upon one another, and frequently it grows on the hold-

fast of kelp. Such individuals are occasionally cast ashore attached to kelp which has been broken loose by storms.

When crowded this barnacle gains room by deepening the base. Shells of large specimens are usually eroded so that the external sculpture cannot be seen. Boring sponges also tend to erode the shell.

A large barnacle outwardly identical with *Balanus nubilus* has been described as a distinct species, *Balanus altissimus* (Cornwall, 1936). Though it differs in the arrangement of the nervous system and occupies a position on the rocks above low tide, it may be only an environmental variety of *B. nubilus*.

References.—Darwin, 1854, p. 253; Pilsbry, 1916, p. 131; Henry, 1942, p. 112; Cornwall, 1951, p. 335.



Balanus crenatus Bruguière.

Description.—Size small, rarely more than one-half inch in diameter even when uncrowded. Shell conical with rhomboidal orifice. When crowded the shell may be cylindrical and rugged or occasionally club-shaped with the upper part wider than the lower.

The carinal margin of each compartment, from the sheath to the base, projects inward slightly beyond the internal surface of the shell. The basal edge of this projecting margin rests on the calcareous base and is crenated like the basal edge of the remainder of the plate.

Colour, white but with a yellowish "epidermis" covering the shell.

Distribution.—North Atlantic and Pacific from the Bering Sea south to Southern California (Santa Barbara).

Found mainly below low tide and occasionally in the intertidal zone, often on worm tubes and shells of molluscs and crabs.

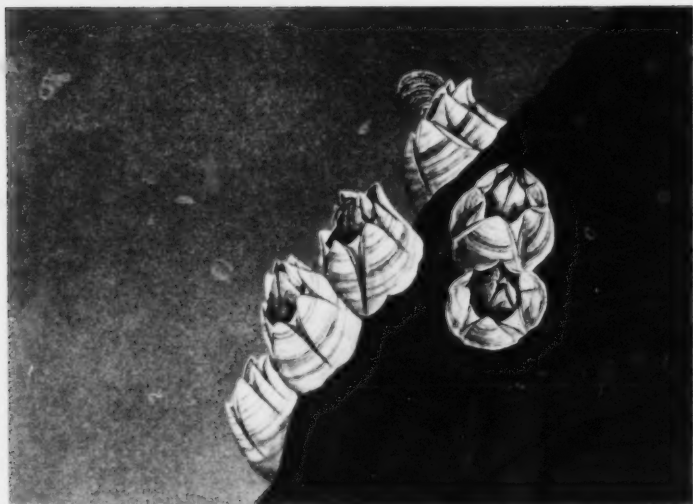
Notes.—*Balanus crenatus* has been found as fossils in Pliocene formation in Britain and in Pleistocene deposits of Norway, Maine,

Canada, and Alaska, indicating that this species has had a wide distribution in the past. Specimens are also present in the Maywood clay (Interglacial) which is exposed on the beach a mile east of Jordan River, Vancouver Island.

On the British Columbia coast *B. crenatus* is often found associated with *B. glandula* and *B. cariosus*, and when the shells are crowded it is difficult to distinguish between them. *B. crenatus* is also commonly found growing on the bottoms of ships; Henry also records this species from brackish water at Port San Juan, B.C.

A closely related species, *Balanus improvisus*, has not yet been definitely recorded for British Columbia. It resembles *B. crenatus* in all details, except that there is an adductor ridge on the scutum.

References.—Darwin, 1854, p. 261; Pilsbry, 1916, p. 165; Henry, 1942, p. 105; Cornwall, 1951, p. 329.



Balanus glandulus Darwin.

Description.—Size small, about one-half inch (10 to 18 mm.) in diameter in uncrowded specimens; height, a little more than half the diameter. Shell cone-shaped, cylindrical or club-shaped when crowded. The variation in the structure of the wall-plates is very marked as some have small regular pores with cross-septa, while others have no pores whatever. When the pores are present, they are filled with white powder, which may obscure the cross-septa. About the best distinguishing character of this species is the jet-black lining of the cover-plates. In young specimens there is a translucent triangular area in each scuta through which this can be seen, but in older specimens the plates are too thick for the black lining to show through.

Colour, usually dirty white or grey.

Distribution.—Aleutian Islands to Lower California, chiefly in the intertidal zone. Abundant on rocks; occasionally in brackish water and on ships' bottoms.

Notes.—*Balanus glandulus* is extremely variable in its appearance possibly because of its wide range in habitat.

References.—Darwin, 1854, p. 265; Pilsbry, 1916, p. 178; Henry, 1942, p. 108; Cornwall, 1951, p. 326.



Balanus rostratus alaskensis Pilsbry.

Description.—Shell large, exceeding 2 inches (56 mm.) in diameter and $1\frac{1}{2}$ inches high. The shell is rugged but not regularly ribbed. In shape it is conic and leans toward the carina, the wall of which is nearly vertical. There is very little erosion except at the orifice, the edges of which are usually broken. One of the most distinctive features of this subspecies is the glossy appearance of the narrow radii which retain some of the dark-brown epidermis that has been worn off the remainder of the shell. The parietal tubes have cross-septa from summit to base.

Colour, usually white but occasionally the shell may be completely covered with brown epidermis. Interior of the cover-plates white.

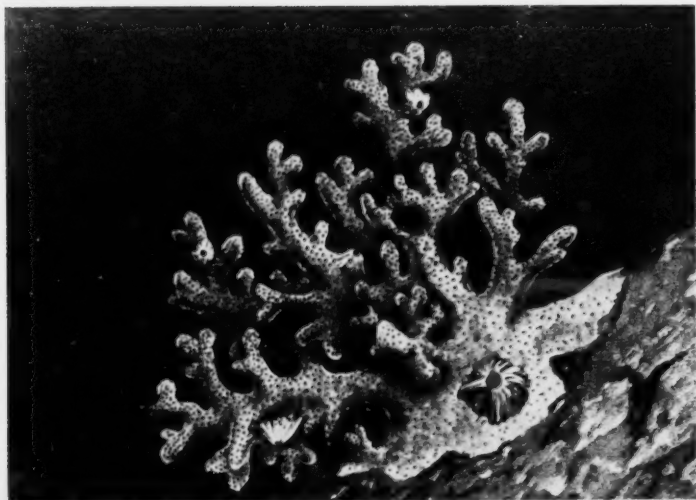
Distribution.—Aleutian Islands, southern coast of Alaska and south to Puget Sound. In British Columbia, specimens have been

taken at Seymour Inlet, Wentworth Island, Brothie Ledge, and William Head (Vancouver Island).

From intertidal zone to 1,115 feet (338 metres) in depth.

Notes.—*Balanus rostratus alaskensis* is frequently dredged up in groups, the younger individuals sometimes growing on top of the older ones, which in time become smothered.

References.—Pilsbry, 1916, p. 141; Cornwall, 1925, p. 484; Henry, 1942, p. 117.



Balanus engbergi Pilsbry.

Description.—Size small, up to three-quarters of an inch (18 mm.) in diameter and a little more in height. Shell a steep-walled cone, occasionally tubular. Deep furrows are usually present between the unequal ribs. The wall-plates are solid, and internally they are finely ribbed below the short sheath. The orifice is small, oval, and with the edge unbroken; its position is not apical as the carina is longer than the other plates.

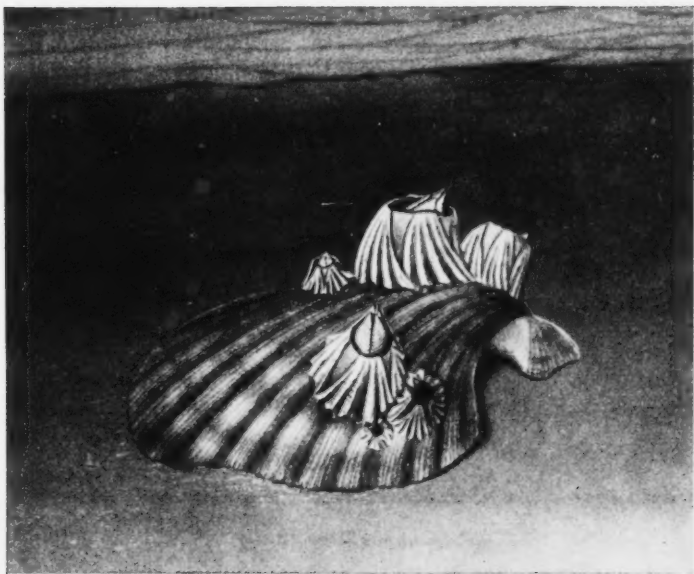
Colour, dirty white; surface mostly covered with epidermis.

Distribution.—Alaska, south to Seal Rocks (Oregon); Puget Sound; Port San Juan, Vancouver Island.

Singly, below low-tide level.

Notes.—This rather rarely seen barnacle is occasionally found growing with, or on, *Balanus nubilus* or on coral but never in closely associated groups.

Reference.—Henry, 1942, p. 107.



Balanus balanus Linnaeus.

Description.—Shell of medium size, up to $1\frac{3}{8}$ inches (35 mm.) in diameter, and about the same in height. Shell conical or tubular, usually strongly ribbed. Orifice relatively small. Pores of the walls large and square with no cross-septa but with longitudinal ribs. Base solid, with radiating grooves on the inner surface. Colour, dirty white, yellowish, or grey. Interior of cover-plates white.

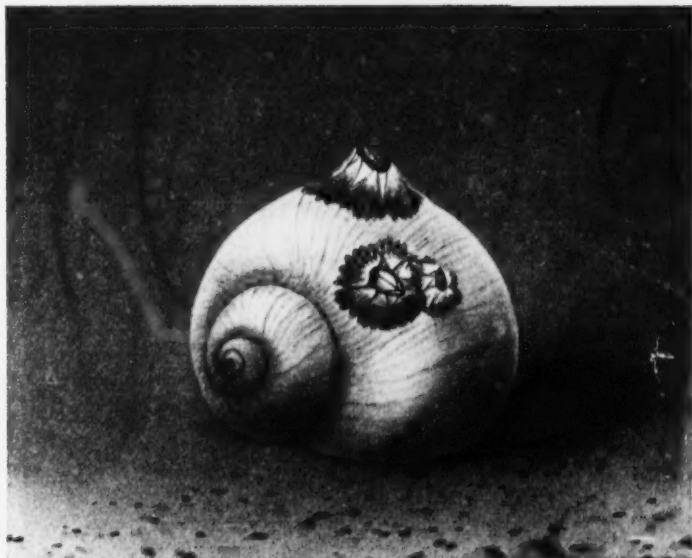
Distribution.—North Atlantic and North Pacific Oceans. In British Columbia, examples have been collected at Langara Island and Seymour Inlet, at depths down to 250 feet (80 metres).

Notes.—*Balanus balanus* is one of the most widely distributed barnacles both at the present time and in the past. Fossils have been found in Pliocene deposits in England, and in Pleistocene formations in Sweden, Canada, and Maine.

A form, *Balanus balanus pugetensis* Pilsbry, differs from the typical species in having a larger orifice and slight differences in other details. Specimens have been taken in Puget Sound and from several locations north as far as Seymour Inlet.

The subspecies *B. b. pugetensis* is often found associated with *Balanus rostratus heteropus*, and the two cannot be easily distinguished. The easiest and most reliable way to differentiate them is to file the shell so that the parietal tubes are exposed. The tubes have no cross-septa in *B. b. pugetensis*; in *B. r. heteropus* the tubes are smaller and have cross-septa.

References.—Pilsbury, 1916, pp. 149 and 163; Henry, 1940, p. 26; Henry, 1942, p. 101.



Balanus hesperius laridomus Pilsbry.

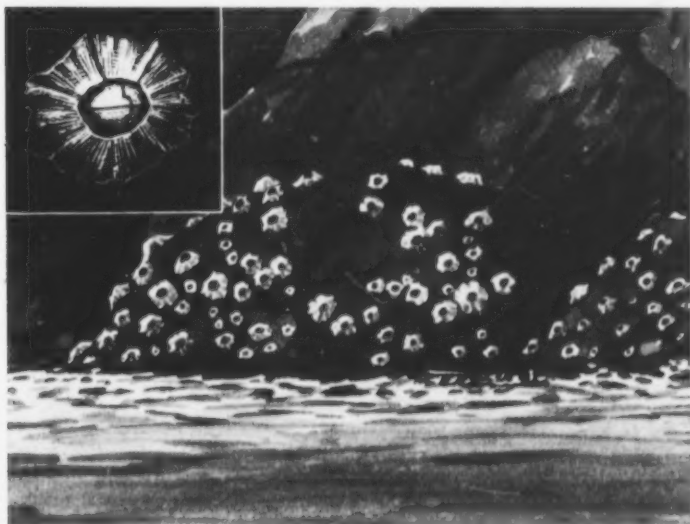
Description.—Size small, up to three-quarters of an inch in diameter (21 mm.); height, a little more than half the diameter. Shell broadly conic, cylindric when crowded. Walls solid, with no parietal tubes. Wall-plates smooth near the apex but usually strongly ribbed in the lower half. External sculpture influenced by pattern of surface to which it is attached. Inner surface with fine small regular ribs, denticulate where they unite with the base. Base solid with shallow grooves radiating from the centre. Orifice pointed at the carinal end, rounded at the rostral end. Sheath, short; scuto and terga near the margin of the orifice.

Colour, dirty white with thin yellowish epidermis.

Distribution.—Monterey, California, north to Alaska. Most of those collected have been taken by dredging at depths ranging from 10 to 35 fathoms.

Notes.—" *B. hesperius lævidomus* grows on various mollusk shells, especially on Pecten, moon-shells and clam-shells and less commonly on other mollusks, brachiopods, crabs, tunicates, and other barnacles. It is found most often associated with *B. crenatus* and less commonly with *B. balanus pugetensis* and *B. rostratus alaskensis*. *B. hesperius lævidomus* is very often the only barnacle represented in dredge from a muddy bottom." (Henry, 1940.)

References.—Pilsbry, 1916, pp. 196-199; Henry, 1940, pp. 31-33.



Chthamalus dalli Pilsbry.

Description.—Shell small, a full-grown specimen containing eggs being a quarter of an inch in greatest diameter. The shell is conical and almost flat, becoming elongate when crowded. The opercular opening is oval in shape and large in proportion to the shell. The junction of the cover-plates forms a cross which is characteristic of the species. Colour, pale grey where the shell is eroded, buff in a narrow basal band where the cuticle remains. White in the interior.

Distribution.—Unalaska, southern coast of Alaska, coasts of British Columbia, Washington, Oregon, and California.

High in the intertidal zone, often in hollows in the rock or on piles.

Notes.—Members of this species grow higher in the intertidal zone than any other barnacles. They are therefore exposed to drying for many hours per day.

In certain areas fully 90 per cent are sometimes found to be parasitized by the isopod, *Homioniscus balani* (Spence Bate), which is usually fatal to the host.

References.—Pilsbry, 1916, p. 316; Cornwall, 1925, p. 472; Henry, 1942, p. 121; Cornwall, 1951, p. 318.

KEY TO THE SPECIES OF GOOSE BARNACLES KNOWN
TO OCCUR IN BRITISH COLUMBIA

- 1 (2) Capitulum with thirteen plates; spines on margin of carina.
Scalpellum columbianum.
- 2 (1) Capitulum with fewer than thirteen plates, no spines on margin.
- 3 (4) Capitulum with five large plates and numerous small plates in several rows.
Mitella polymerus.
- 4 (3) Capitulum with five large plates only.
Genus *Lepas.*
- 5 (10) Base of peduncle not expanded to form a float.
- 6 (9) Tergum with no notch on the scutal margin.
- 7 (8) Plates finely striated; not more than two branchiae on each side of body.
Lepas anatifera.
- 8 (7) Plates smooth (unstriated); three or more branchiae on each side of body.
Lepas hilli.
- 9 (6) Tergum with a notch on the scutal margin.
Lepas pectinata pacifica.
- 10 (5) Base of peduncle expanded to form a float.
Lepas fascicularis.
- (See Key to Whale Barnacles for *Conchoderma.*)



Scalpellum columbianum Pilsbry.

Description.—Size small, capitulum up to 11 mm. (five-sixteenths of an inch) in length, peduncle 4 mm. (one-eighth inch) in length. Capitulum enclosed in thirteen plates and covered with a thin cuticle. Many spines on the margin of the carina. Scales on peduncle partly buried and not regularly arranged. Colour, dirty white on the plates, cuticle yellowish. Peduncle yellowish.

Distribution.—Southern coast of British Columbia and Puget Sound. In British Columbia, specimens have been taken at Lowe Inlet, Burrard Inlet, and Departure Bay (Nanaimo).

Deep water, at least to 290 feet.

Notes.—*Scalpellum columbianum* is a small, deep-water goose barnacle. Of the 150 known species in the world, most are from deep water, down to 2,000 fathoms (12,000 feet) or more.

Individuals from a depth of 30 fathoms in Departure Bay near Nanaimo (February, 1928) contained embryos in several different stages of development, a possible adaptation to the deep-water habitat. (See also Barnard, 1924.)

References.—Pilsbry, 1909, p. 367; Cornwall, 1930, p. 215; Henry, 1940 (a), p. 232.



Mitella polymerus (Sowerby).

Description.—Size large, capitulum up to 45 mm. (1¾ inches) in length, peduncle up to 6 inches in length. Capitulum enclosed by two large plates on each side and one (the carina) on the back edge. Below these are several rows of small plates, numbering up to a hundred or more, depending upon the age of the barnacle. Surface of peduncle with many small calcareous scales.

Colour, creamy white on the plates, dark brown in the inter-spaces and on the peduncle. The cirri are faintly yellow.

Distribution.—World-wide; in the littoral zone below half-tide mark but only where there is strong wave-action. Occasionally specimens have been found growing on the whale barnacle *Coronula diadema*, and sometimes on ships.

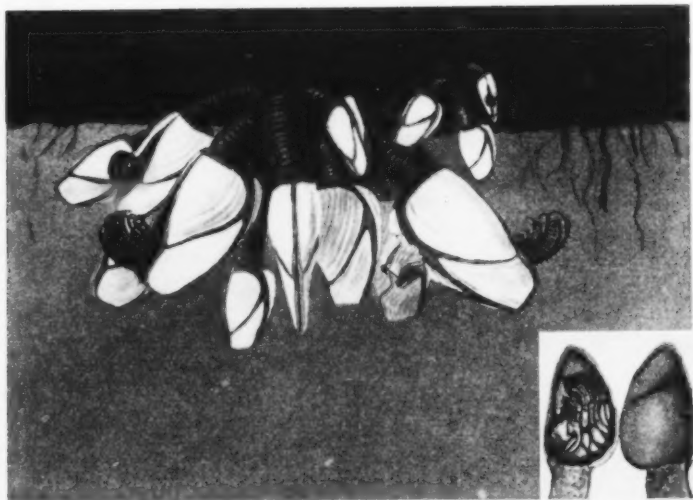
Notes.—This is the only pedunculate barnacle found on the British Columbia coast above the low-tide level.

Specimens vary greatly in length. Those on the edge of a group usually have short peduncles while those at the centre may have stalks 6 inches long.

When a sessile barnacle becomes attached to a plate on the capitulum, in time the outer lamina splits off carrying the sessile barnacle with it, possibly as a result of the tensions set up between the two shells. Such an event provides the only known case where any portion of the calcareous covering of a barnacle is detached during the life of the animal.

The peduncle can be used as food. When steamed for twenty minutes and skinned, the flesh is red and tastes like lobster.

References.—Darwin, 1851, p. 307 (under the name *Pollicipes polymerus*); Pilsbry, 1907, p. 5; Henry, 1940 (*a*), p. 234; Cornwall, 1925, p. 486, and 1951, p. 339.



Lepas anatifera Linnaeus.

Description.—Size large, capitulum up to 43 mm. ($1\frac{3}{4}$ inches) in length, peduncle up to 8 inches in length. Capitulum enclosed in five finely striated plates. A tooth is usually present on the lower angle of the right scutum, but is often absent from the left. A series of square spots often present on the scutum. Space between carina and other valves narrow. Never more than two branchiæ on each side. Scales irregularly scattered over peduncle in mature specimens; minute spines are present on young individuals.

Colour, dirty white or bluish-grey on plates, bright scarlet-orange on edges of orifice. Dull orange-brown on interspaces; purplish-brown on peduncle.

Distribution.—World-wide, often attached to driftwood.

Notes.—This is perhaps the most common pedunculate barnacle, being found on driftwood all along the coast. It resembles *Lepas hilli* very closely but can be distinguished from it by the presence of fine striations on the valves and one pair of filamentary appendages (branchiæ) on each side of the body. (See Fig. 9).

The name "anatifera," meaning goose-bearer, refers to the legendary origin of the barnacle goose.

References. — Darwin, 1851, p. 73; Pilsbry, 1907, p. 79; Henry, 1940, p. 226; Cornwall, 1951, p. 342.

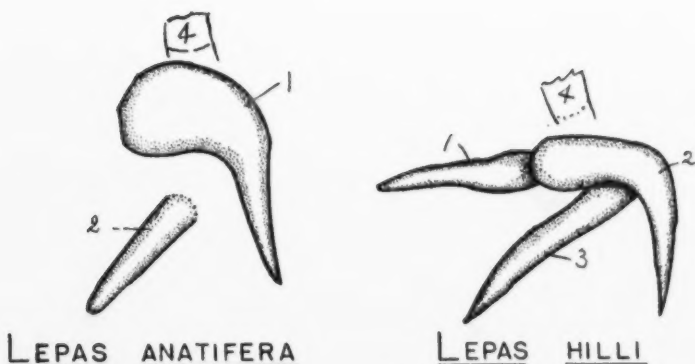


Fig. 9. Branchiae of *Lepas anatifera* and *Lepas hilli*. 1, 2, and 3, filamentary appendages; 4, base of first cirrus. (Cornwall.)

Lepas hilli Leach.

Description.—Size large, capitulum up to 42 mm. ($1\frac{3}{4}$ inches) in length, peduncle up to 5 inches in length. Capitulum flattened and enclosed in five unstriated plates. No tooth present on the lower angle of either scutum. Space between carina and other valves broad. Always three or more branchiae on each side of body. Peduncle naked; in some, with small transparent plates.

Colour, dirty white or bluish-grey on plates, orange-brown on interspaces. Purplish-brown on peduncle turning to bright orange near the capitulum. The eggs are blue.

Distribution.—World-wide, often attached to driftwood.

Notes.—*Lepas hilli* resembles *L. anatifera* very closely and is often associated with this species. It is most readily recognized by the possession of three or more filamentary appendages on each side of the body, as compared with two in *L. anatifera* (see Fig. 9).

References.—Darwin, 1851, p. 77; Pilsbry, 1907, p. 80; Cornwall, 1925, p. 490.



Lepas pectinata pacifica Henry.

Description.—Size small to medium, capitulum 20 mm. (three-quarters of an inch) in length, peduncle 16 mm. in length. Capitulum enclosed in five thin, brittle plates radially striated. Tergum triangular with a notch on the scutal margin close to the opening. One branchia on each side. Peduncle variable in length, often longer than capitulum; smooth, with no spines in young individuals. Colour, white on plates, light brownish-yellow on peduncle (in alcohol).

Distribution.—Eastern Pacific from Alaska south to Oregon.

Notes.—This small goose barnacle is pelagic, often attached to floating kelp or to driftwood. It has been recorded from several localities in the Queen Charlotte Islands (Henry) but not yet from Vancouver Island. It must occur here at times, however, since specimens have been collected at Friday Harbor, San Juan Island.

References.—Henry, 1940 (*a*), p. 228.



Lepas fascicularis Ellis and Solander.

Description.—Size large, capitulum up to 47 mm. ($1\frac{7}{8}$ inches) in length, peduncle up to 10 mm. (three-eighths of an inch) in length. Capitulum enclosed in five thin, paper-like plates each covered by a spinose membrane. Base of peduncle attached to a float resembling a gelatinous ball.

Colour, various shades of light brown or dirty white in fresh specimens; yellow in preserved specimens.

Distribution.—Atlantic, Pacific, and Indian Oceans.

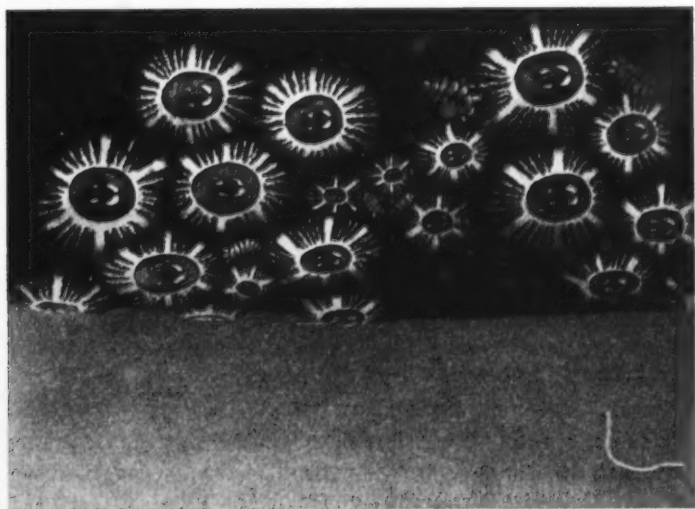
Notes.—*Lepas fascicularis* is the only barnacle known to develop a float. It is supposed that the young attach themselves to a small object, such as a grain of sawdust, after which the float is formed by secretions from the cement glands. Several individuals may be attached to one float and in turn each may provide support for smaller members which are attached directly to the cover-plates. Colonies drift freely in the sea and occasionally large numbers are driven ashore by storms.

A subspecies, *L. f. aurivilli* Nilsson-Cantell, has been recorded from several localities along the British Columbia coast by Henry (1940).

References.—Darwin, 1851, p. 92; Pilsbry, 1907, p. 81; Henry, 1940, p. 231; Cornwall, 1951, p. 340.

KEY TO SPECIES OF WHALE BARNACLES KNOWN
TO OCCUR IN COASTAL WATERS OF BRITISH
COLUMBIA.

- 1 (6) No peduncle; shell attached direct to skin of whale.
- 2 (3) Body-chamber surrounded by thirty to forty rays.
Cryptolepas rachianecti.
- 3 (2) Body-chamber not surrounded by rays.
- 4 (5) Shell crown-shaped with hexagonal opening.
Coronula diadema.
- 5 (4) Shell depressed, often with ovoid opening.
Coronula reginæ.
- 6 (1) Peduncle or pseudo-peduncle present.
- 7 (8) Pedunculate in appearance but with rudimentary star-shaped shell at point of attachment and with a hood-like "capitulum."
Xenobalanus globicipitis.
- 8 (7) With true peduncle and capitulum; shell absent.
- 9 (10) Capitulum fleshy with ear-like appendages.
Conchoderma auritum.
- 10 (9) Capitulum flask-shaped with no ear-like appendages.
Conchoderma virgatum.



Cryptolepas rachianecti Dall.

Description.—Size up to $2\frac{1}{4}$ inches. Shell ovoid with an ovoid opening; greatly compressed and almost completely imbedded in the skin of the whale. Body-chamber surrounded by about thirty rays which project above the surface of the skin. Cover-plates, usually two, almost invisible. Opercular opening covered by a strong membrane with a central hood through which the cirri are protruded. Colour of the shell, white where eroded; opercular membrane, sulphur yellow.

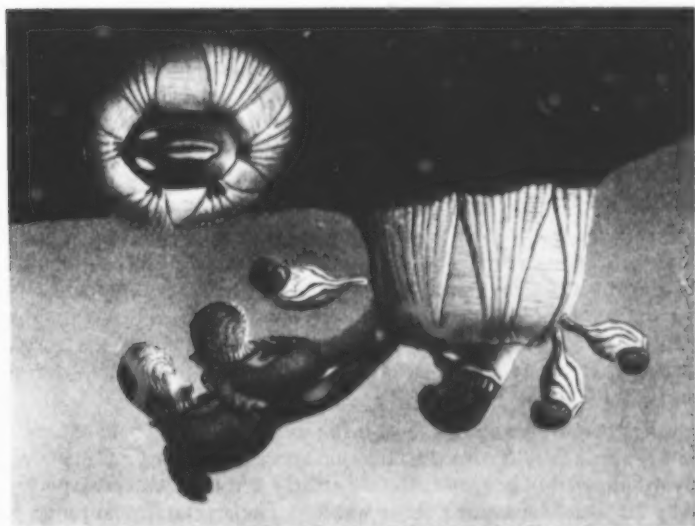
Distribution.—On California grey whale *Eschrichtius glaucus* (Cope) which is confined to the North Pacific Ocean.

Notes.—*Cryptolepas rachianecti* is almost wholly embedded in the whale's skin, usually on the head and under-parts of flippers and fluke. "It is excessively variable in size, proportion of diameter to height, and shape of the ribs or lamellæ, which may be short, with a rounded (semicircular) outline, or long, and triangular in outline. The ribs may have many or very few branches. In young speci-

mens the shape is that of a thick disk with rounded periphery, and the folds are simple. At all stages their free edges are beautifully crenulated." (Pilsbry.)

The amphipod *Cyamus scammoni* Lutken is often found on the opercular membrane or in the shallow cavities of the eroded radii.

References.—Pilsbry, 1916, p. 279; Margolis, 1954, p. 275.



Coronula diadema (Linnaeus) with *Conchoderma auritum* (left)
and *Conchoderma virgatum* (right).

Description.—Size up to 3 inches in diameter. Shell crown-shaped or cask-shaped, narrower at the top than at the base and with a hexagonal opening. Alæ corrugated. Three triangular openings produced at each corner of the major opening where the surface of the ribs has been eroded. Cavities of the shell invaded by skin of whale as an anchor. Ribs convex, crossed by narrow, minutely beaded rugæ. Radii thin, space behind them filled with branches of the ovaries. Body-chamber cup-shaped. The scuta are small and are placed near the rostral end of the orifice. The terga, when present, are represented by a thin plate of shell barely visible to the naked eye. The opercular opening is covered by a strong membrane with a central hood through which the cirri are thrust. Branchiæ in two folds almost completely surround the body.

Colour of shell, white; opercular membrane, light yellow, occasionally with a purplish tinge; cirri and mouth parts, pale yellow. Shell and opercular membrane usually discoloured by a brownish growth of the diatom *Licmophora onassis*. (The species was recently described by Hustedt, from Antarctic specimens. It was identified from barnacles of British Columbia humpbacks by Dr. Ruth Patrick, Curator of Limnology, Acad. Nat. Sci. Philad.)

Distribution.—World-wide on humpback whale, *Megaptera nodosa* (Bonnaterre). *C. diadema* occurs mostly on the summits of the tubercles and protuberances of the head and flippers and on the knob at the tip of the lower jaw. It occurs also on the ventral grooves and in the region of the genital and anal apertures. It occurs in scattered numbers over the sides, rarely on the dorsal surface.

Notes.—*Coronula diadema* is the most common whale barnacle but is apparently confined to the one species of whale. It is stated by whaling-station operators that nearly a ton of these barnacles may be attached to one large whale. Their presence must be a source of irritation to the whale as these mammals have been seen engaged in rubbing themselves against rocks apparently in an effort to remove the barnacles.

In *C. diadema* the branchiæ are the largest of any known barnacle. It is interesting to note that in all whale barnacles, and in parasites of whales generally, these respiratory organs are comparatively very large—a possible adaptation for living in warm water where less oxygen is available while the whale is migrating through the tropics.

Most *C. diadema* probably have a life-cycle of less than one year. They are mostly small in the early summer months, but are considerably larger and many have dropped off or have been rubbed off by the end of the summer. (See Angot, M. 1951, Rapport Scientifique sur les expéditions balinières de Madagascar, Mem. Inst. Sci. Madagascar, Ser. A. 6 (2), 439–486; also Olsen, O. 1914–15, Hvaler og hvalfangst i Sydafrika, Bergens Museums Aarbok., 1914–15, No. 5, pp. 1–56; Gordon C. Pike, Pers. Comm.)

References.—Darwin, 1854, p. 417; Pilsbry, 1916, p. 273; Cornwall, 1924 (*a*), p. 421; 1927, p. 504; Scheffer, 1939, p. 67; Margolis, 1954, p. 274.



Coronula reginae Darwin.

Description.—Size up to $2\frac{1}{2}$ inches in diameter and three-quarters of an inch in height. Shell similar to that of *C. diadema* but much depressed and partly imbedded in skin of the whale. Alæ smooth. Opercular opening ovoid or hexagonal. Scuta, when present, appear as white spots near the rostral margin of the orifice.

No triangular openings at corners of opercular opening except in old specimens. Parietal ribs flattened, striated, with granulated surface and crenated edges. Body-chamber cup-shaped, with lower opening smaller than the orifice. Cover-plates absent; opercular opening covered by a strong membrane with a central hood through which the cirri are thrust.

Colour of shell, white; opercular membrane, light to dark yellow.

Distribution.—World-wide on humpback whale, *Megaptera nodosa* (Bonnaterre), mainly on the lower lips, throat, and flippers and often associated with *C. diadema*.

Notes.—*Coronula reginae* is less common than *C. diadema* and is more deeply embedded in the skin of the whale. It is easily distinguished by its smaller size, depressed shape, and lack of triangular openings in young specimens. It has been found once on a sperm whale in British Columbia (Gordon C. Pike).

References.—Darwin, 1854, p. 419; Pilsbry, 1916, p. 275; Cornwall, 1927, p. 507; Margolis, 1954, p. 274.



Xenobalanus globicipitis Steenstrup.

Description.—A sessile species, pedunculate in appearance. Size about 2 inches in length. Shell rudimentary, star-shaped, about a quarter of an inch in diameter, almost completely embedded in skin of the whale. Mantle extended to cover whole of body, and forming what appears to be a peduncle. Pseudo-peduncle cylindrical, flexible, narrowest at base, and with reflexed hood at the outer end surrounding the opening through which the cirri are protruded. Opercular valves absent.

Colour of shell, white; pseudo-peduncle, brown or dark chocolate-red; hood, light brown.

Distribution.—World-wide but not common on the sei whale (*Balaenoptera borealis* Lesson), the common finback (*Balaenoptera physalus* (Linnaeus)), and the blackfish, or pilot whale (*Globicephala ventricosa* (Lacepède)).

Notes.—In spite of its pedunculate appearance, *Xenobalanus globicipitis* is an acorn barnacle in which the body has been elongated to form a false peduncle. Groups consisting of several

individuals have been found attached to the tips of the flippers of the sei whale, an unusual habitat for any barnacle (Cachalot Whaling Station, 1925), and once it was found attached to the side of the head of a blue whale (Gordon C. Pike). Star-shaped scars on the skin of the whale mark old points of attachment.

References.—Darwin, 1854, p. 440; Pilsbry, 1916, p. 285; Cornwall, 1927, p. 10; Margolis, 1954, p. 275.

***Conchoderma auritum* (Linnaeus). Rabbit-eared barnacle.**

(See illustration of *Coronula diadema*.)

Description.—Size large, up to 5 inches in total length. Capitulum fleshy, with two large folded ear-like appendages, and with two to five minute valves, remote from each other. Opercular opening surrounded by hood. Two small scuta below the opening visible through transparent outer layer of membrane. Cirri short, much flattened, and leathery. Peduncle cylindrical, expanded at base for attachment.

Colour, faint pink, occasionally with irregular mottled patches of brown or purple on the capitulum; peduncle irregularly striped with brown or purple; cirri, white.

Distribution.—World-wide, attached to shells of *Coronula* on whales; occasionally on a ship's bottom or on buoys and rocks.

Notes.—*Conchoderma auritum* is most often found attached to the shells of *Coronula* on the humpback whale; sometimes more than fifty are attached to one shell. "Rarely a specimen is found attached to the base of the teeth of an old sperm whale" (Sheffer, 1939).

Gordon C. Pike reports finding specimens of *C. auritum* on sperm and fin whales taken in British Columbia. In each case the barnacles were associated with a deformation or an apathological condition of the jaws, baleen, or teeth.

Each barnacle is usually oriented with the opening facing in the direction the whale swims. The food-laden water passes through the opening and over the feeding appendages, then out through the two "ears" which have tubular openings (MacGintie and MacGintie, Natural History of Marine Animals, McGraw-Hill Book Co., 1949).

References.—Darwin, 1851, p. 141; Pilsbry, 1907, p. 99; Cornwall, 1924 (a), p. 425, and 1927, p. 413; Scheffer, 1939, p. 67; Margolis, 1954, p. 274.

***Conchoderma virgatum* (Spengler).**

(See illustration of *Coronula diadema*.)

Description.—Size variable, up to 2 inches in length. 'Capitulum variable in shape, usually roughly cylindrical tapering to the peduncle. Cover-plates calcified; no ear-like projections on capitulum. Cirri short, much flattened, and leathery. Peduncle cylindrical and narrow, slightly expanded at its point of attachment.

Colour, capitulum and peduncle grey with longitudinal stripes of purplish-brown or black. Cirri are dark, nearly black.

Distribution.—World-wide; on ships' bottoms, or any floating object. Rarely attached to whale barnacles; associated with *Conchoderma auritum*.

Notes.—Occasionally *C. virgatum* is found attached to a large copepod that lives on the marlin swordfish (MacGintie and MacGintie, *ibid.*), and once it was found attached to the stalk of the parasitic copepod *Penella balanopterae* which in turn was buried in the blubber of a finback whale (Gordon C. Pike).

References.—Darwin, 1851; Pilsbry, 1907.

POSSIBLE ADDITIONAL SPECIES

The following species have been recorded from the North-east Pacific Ocean but have not yet been found as residents in British Columbia:—

Balanus balanoides (Linnæus). Recorded from Alaska (Henry, 1942).

Balanus improvisus Darwin. Found on "inlets to flood valves on naval vessels cruising on the east and west coasts of the United States" (Henry, 1942). Individuals, apparently of this species, have also been found in Esquimalt Lagoon, near Victoria, B.C.

Balanus tintinnabulum californicus Pilsbry. Found on flood valves of ships (Henry, 1942). A small specimen was also found attached to the shell of *Coronula diadema* on a humpback whale (Gordon C. Pike).

Balanus trigonus Darwin. Two small specimens were found attached to the shell of *Coronula diadema* on a humpback whale (Gordon C. Pike).

Coronula complanata (Mörch). One specimen was collected from a whale; associated with *C. diadema* and *C. reginæ*.

Lepas anserifera Linnæus. A cosmopolitan species likely to be found on the British Columbia coast at any time.

Balanus rostratus heteropus Pilsbry. Puget Sound, San Juan Island.

Balanus balanus pugetensis Pilsbry. San Juan Island.

Balanus crenatus curviscutum Pilsbry. Alaska.

Balanus hesperius Pilsbry. Alaska.

Tubicnalla major Lamarch. On whales in the North Pacific.

Alepas pacifica Pilsbry. On jelly-fish in the North Pacific.

GLOSSARY

An endeavour has been made to bring together terms used in describing *all* barnacles. Many of these terms are not used in describing the barnacles of the British Columbia coast as the number of species here is very limited.

Acorn barnacle.—A barnacle without a stalk, attached direct to its support.

Adductor muscle or *adductor scutorum*.—The main muscle for closing the operculum; it is attached to each scutum at the adductor muscle pit.

Adductor pit.—The pit or depression for the attachment of the adductor muscle.

Adductor ridge.—A ridge on the interior of the scutum between the tergal margin and the pit for the attachment of the adductor muscle.

Ala, pl. *alæ*.—The thin portion of the wall-plate which projects from the side and is overlapped by the radius and part of the adjoining plate.

Anal opening or *anus*.—The posterior opening of the alimentary canal. It opens through the dorsal base of the penis.

Antennules.—Two segmented organs which protrude between the valves during the free-swimming stage. The third segment of each forms a sucker-like disk connected with the cement glands, and serves for the first attachment of the animal.

Antenna, pl. *antennæ*.—Articulated organs of sensation present during part of the free-swimming stages of barnacles.

Apical ridge.—A ridge on the interior of the scutum. (Found only in species of *Verruca* of tropical seas.)

Apex.—The upper angle of the scutum and of the tergum. The upper part of the plates forming the wall.

Articular furrow.—A furrow on the tergal margin of the scutum and the scutal margin of the tergum, for the articulation of the two valves.

Articular ribs.—Ribs on the interior of the scutum of *Verruca* below the articular furrow; variable in number and position.

Articular ridge.—The ridge on the scutum and also on the tergum which helps to lock the two valves together.

- Basis or base*.—The floor-like part of the barnacle which is attached to the rock or other support; calcareous in some species, membranous in others.
- Basal*.—Referring to the parts adjacent to the basis, or base.
- Basal margin*.—The margin of the scutum between the tergal margin and the occludent margin.
- Branchia*, pl. *branchiae*.—Respiratory organs. One or more pair are always present in the *Balanidae*.
- Capitulum*.—The enlarged and usually flattened part of a pedunculate barnacle in which the body is enclosed.
- Carina*.—The compartment or plate in the shell of *Balanus* with two alæ. In *Chthamalus* the carina and rostrum both have alæ. The long posterior cirri are next to the carina. In pedunculate barnacles it is the keel-like plate extending up between the terga.
- Carinal*.—Referring to the parts adjacent to the carina.
- Carinolaterals*.—The narrow compartments of the shell of *Balanus* next to the carina. They have alæ on one side and radii on the other.
- Carinal latus*.—The plate projecting under the carina of the capitulum of *Scalpellum*.
- Carinal margin*.—The margin of the terga next to the carina.
- Caudal appendages* or *caudal furca*.—The simple or segmented appendages seated over the anus; present, with few exceptions, in all the *Lepadidea* and *Verrucidea*.
- Chitin*.—An amorphous horny substance forming the harder part of the outer integument of Crustacea.
- Cirrus*, pl. *cirri*.—The thoracic appendages or legs of the barnacle. They consist of the peduncle, or protopodite, bearing two segmented rami. The cirri form the sweep that captures the food.
- Cirripedia*.—The subclass of the Crustacea that includes barnacles.
- Compartments*.—The plates forming the wall of the shell.
- Complemental males*.—Small male barnacles that assist in the fertilization of some species of barnacles.
- Crests for the depressor muscles*.—These crests, or grooves, run from the basal margin or the tergum toward the apex.
- Cross-septa*.—The divisions between the cells in the parietal tubes.
- Cypris*.—The last free-swimming stage of the barnacle larva.

- Depressor muscles*.—Muscles attached to the crests on the terga for closing the opercular plates.
- Epidermis*.—The outer non-sensitive layer of the skin.
- Exuviation*.—The moulting of the membranous covering of the body.
- Filamentary appendages*.—Tapering appendages attached to the bases of several cirri in some species; to the prosoma in others. They are believed to be respiratory organs.
- Ganglion*.—A mass or concentration of nerve cells.
- Gnathites*.—Mouth parts. *See* trophi.
- Hermaphrodite*.—An individual having both male and female organs of reproduction.
- Inframedian latus*.—The plate on the capitulum of a pedunculate barnacle set below the scutum and upper latus.
- Infra-oesophageal ganglion*.—The ganglion located beneath the oesophagus.
- Labrum*.—The organ which acts as an upper lip. In the pedunculate barnacles it is thick and rounded. In *Balanus* it is not thick and has a central notch.
- Lacunæ*.—Spaces between the tissues that serve in place of vessels for the circulation of the body fluids.
- Lamina, outer and inner*.—The shelly wall forming the compartments of sessile barnacles. The parietal tubes, when present, are between them.
- Laterals*.—The plates in the wall of *Balanus* between the carinolaterals and the rostrum; in *Chthamalus* between carina and rostromaterals.
- Latera*.—The plates forming the lower rows at the base of the capitulum.
- Mandibles*.—The anterior pair of mouth appendages.
- Mantle*.—The lining of the cavity in which the body lies.
- Maxilla, pl. maxillæ or maxillulæ*, also called *first maxillæ*.—Mouth parts set parallel with the mandibles, pointing toward the labrum.
- Metanauplius*.—The larval stage following the nauplius. Fig. 7.
- Moulting*.—The casting-off of the membranous covering of the body and of its appendages; exuviation.

- Nauplius*, pl. *nauplii*.—The first free-swimming stage of crustaceans.
- Normal*.—Conforming to type. An uncrowded or free-growing specimen.
- Œsophagus* or *esophagus*.—The gullet.
- Œsophageal ring*.—The nerves joining the supra-œsophageal ganglion with the infra-œsophageal ganglion. One group passes on each side of the œsophagus.
- Outer maxilla* or *second maxilla*.—Those organs set close together on a prominence facing the labrum and serving as an under-lip.
- Occludent margin*.—The margin of the opening through which the cirri are protruded.
- Olfactory organs*.—A pair of structures opening by minute orifices, sometimes elevated on tubular papillæ, situated on the outer side of the outer maxillæ. These were described by Darwin as "olfactory organs," but it has since been shown that they are excretory organs.
- Operculum*.—The movable plates, scuta and terga and the membrane connecting them, that form the cover of the opening through which the cirri are protruded.
- Opercular membrane*.—The membrane surrounding the opening through which the cirri are protruded.
- Orifice*.—The opening through which the cirri are protruded.
- Ovigerous lamellæ*.—Delicate, transparent membranes which hold the eggs or ova in sheets; the ova lie in layers from two to four deep on each side of the sack in pedunculate barnacles.
- Paries*, pl. *parietes*.—The wall-plates of sessile barnacles.
- Palpus*, pl. *palpi*.—Two club-shaped sensory organs attached to the upper margin of the labrum.
- Pectinated*.—Having a comb-like edge.
- Peduncle*.—The stalk or support of the capitulum. Also the support of the two rami of the cirri.
- Pedunculate*.—A barnacle having a peduncle or stalk.
- Penis*.—The probosciform male organ of reproduction.
- Prosoma*.—The soft rounded portion of the body. It is in the normal position of the head of an animal.
- Protopodite*.—The segmented support or peduncle of the two rami of the cirri.

- Pit for the lateral depressor muscle*.—A pit or depression on the basal margin of the scutum.
- Radius*, pl. *radii*.—The part of the wall-plate that overlaps the ala of the next plate. Fig. 3.
- Ramus*, pl. *rami*.—A branch of the cirrus; each cirrus has two rami, anterior and posterior.
- Rostral latus*.—The lateral plate under the basal margin of the scutum and partly under the rostrum; not present in all pedunculate barnacles.
- Rostral*.—Referring to the parts adjacent to the rostrum.
- Rostrum*.—The plate opposite the carina of a sessile barnacle.
- Rostrolaterals*.—These plates have radii on both sides.
- Ruga*, pl. *rugæ*.—A wrinkle or fold.
- Scutum*, pl. *scuta*.—The two triangular opercular plates nearest the prosoma.
- Septum*, pl. *septa*.—The walls dividing the parietal tubes into a series of cells. Also the walls between the parietal tubes.
- Segment*.—One of the articulated series of divisions of which the cirri are made up.
- Serrate*.—With a saw-like edge.
- Sessile*.—Immovably attached to a support.
- Sheath*.—The part of the shell surrounding the orifice.
- Spine*.—A rigid pointed projection.
- Spinose*.—Covered with spines.
- Splanchnic nerves*.—The two large nerves connected to the infra-œsophageal ganglion.
- Subrostrum*.—The plate under the rostrum of a pedunculate barnacle.
- Subcarina*.—The plate under the carina of a pedunculate barnacle.
- Supra-œsophageal ganglion*.—The ganglion located above the œsophagus.
- Suture*.—The line or seam formed by the union of two plates. In some species the edges of the plates are toothed and interlocked, giving the whole structure great strength.
- Spur*.—The projection on the basal margin of the tergum.
- Tergal margin*.—The margin of the scutum adjacent to the tergum.
- Tergum*, pl. *terga*.—The opercular plate next to the carina.

Thorax.—The part of the body bearing the cirri.

Trophi or *gnathites*.—The mouth parts—labrum, mandibles, maxilla, and outer maxilla.

Transverse septa.—The walls dividing the parietal tubes into a series of cells.

Upper latus.—The valves, or plates, on the capitulum of a pedunculate barnacle which project between the lower margin of the tergum and the scutum.

Valves.—The plates covering the capitulum of a pedunculate barnacle; also the cover-plates.

Whale barnacle.—An acorn barnacle found on certain species of whales. (The pedunculate barnacles *Conchoderma auritum* and *C. virgatum* are commonly included with the whale barnacles though they are not confined to whales.)

BIBLIOGRAPHY

BARNARD, K. H.

1924. "Cirripedia." *Annals of the South Africa Museum*. Vol. 20.

BROCH, H. J.

- 1914-1916. *Papers from Dr. Th. Mortensen's Pacific Expedition*. 1914-1916.

Sæterkr af Vidensk Medd. fra Dansk naturh. Foren. Bd. 91. Odense.

CORNWALL, IRA E.

1924. "Some Littoral Barnacles from William Head, British Columbia." *Canadian Field-Naturalist*. Vol. 38, No. 3, pp. 41-43.

- 1924 (a). "Notes on the West Coast Whale Barnacles." *Proceedings of the California Academy of Sciences*. Series 4, Vol. 13, No. 26, pp. 421-431.

1925. "A Review of the Cirripedia of the Coast of British Columbia." *Contributions to Canadian Biology*. New series, Vol. 2, Part 2, pp. 471-502.

1927. "Some North Pacific Whale Barnacles." *Contributions to Canadian Biology and Fisheries*. New series, Vol. 3, No. 23, pp. 503-517.

1928. "Collecting at Cachalot Whaling Station." *Canadian Field-Naturalist*. Vol. 42, No. 1, pp. 9-12.

1930. "A Barnacle (*Scalpellum columbianum*) from Departure Bay, British Columbia." *Contributions to Canadian Biology and Fisheries*. Vol. 5, No. 9, pp. 215-217.

1936. "On the Nervous System of Four British Columbia Barnacles (One New Species)." *Journal of the Biological Board of Canada*. Vol. 1, No. 6, pp. 469-475.

1951. "The Barnacles of California (Cirripedia)." *Wasmann Journal of Biology*. Vol. 9, No. 3, pp. 311-346.

1953. "The Central Nervous System of Barnacles (Cirripedia)." *Journal of the Fisheries Research Board of Canada*. Vol. 10, No. 2, pp. 76-84.

1955. "Arthropoda: Cirripedia." *Canadian Pacific Fauna Series*, Fisheries Research Board of Canada. In press.

DARWIN, CHARLES.

1851. "A Monograph on the Sub-class Cirripedia. Pedunculate Barnacles." Ray Society, London, England.
1854. "A Monograph on the Sub-class Cirripedia. Sessile Barnacles." Ray Society, London, England.

GRUVEL, A.

1905. "Monographie des Cirrhipedes au Thecostraces." Libraires de L'Academie de Medicine, Paris.

HENRY, DORA P.

- 1940 (a). "Notes on Some Pedunculate Barnacles from the Pacific Coast." Proceedings of the U.S. National Museum. Vol. 88, No. 3081, pp. 225-236.
1940 (b). "The Cirripedia of Puget Sound with Key to the Species." University of Washington Publications in Oceanography. Vol. 4, No. 1, pp. 1-48.
1941. "Notes on Some Sessile Barnacles from Lower California and the West Coast of Mexico." Proceedings of the New England Zoological Club. Vol. 18, pp. 99-106.
1942. "Studies on the Sessile Cirripedia of the Pacific Coast of North America." University of Washington Publications in Oceanography. Vol. 4, No. 3, pp. 95-134.

HIRO, FUJI.

1935. "The Fauna of Akkeshi Bay. Cirripedia." Hokkaido Imperial University. Series 6, No. 4.
1937. "Studies on the Cirripedian Fauna of Japan." Memoirs of the College of Science, Kyoto Imperial University. Series B, Vol. 12.

HOEK, P. P. C.

1883. "Report on the Cirripedia." Challenger Reports, Zoology, Vol. 8.

MARGOLIS, L.

1954. "List of the Parasites Recorded from Sea Mammals Caught off the West Coast of North America." Journal of the Fisheries Research Board of Canada. Vol. 11, No. 3, pp. 267-283.

PILSBRY, H. A.

1907. "The Barnacles (Cirripedia) Contained in the Collections of the U.S. National Museum." U.S. National Museum Bulletin. No. 60, pp. 1-222.

1909. "A New Species of *Scalpellum* from British Columbia." Proceedings of the Academy of Sciences of Philadelphia. Vol. 61, pp. 367-368.

1916. "The Sessile Barnacles (Cirripedia) Contained in the Collections of the U.S. National Museum; Including a Monograph of the American Species." U.S. National Museum Bulletin. No. 93, pp. 1-366.

1921. "Barnacles of the San Juan Islands, Washington." Proceedings of U.S. National Museum. Vol. 59, No. 2362, pp. 111-115.

SCHEFFER, VICTOR B.

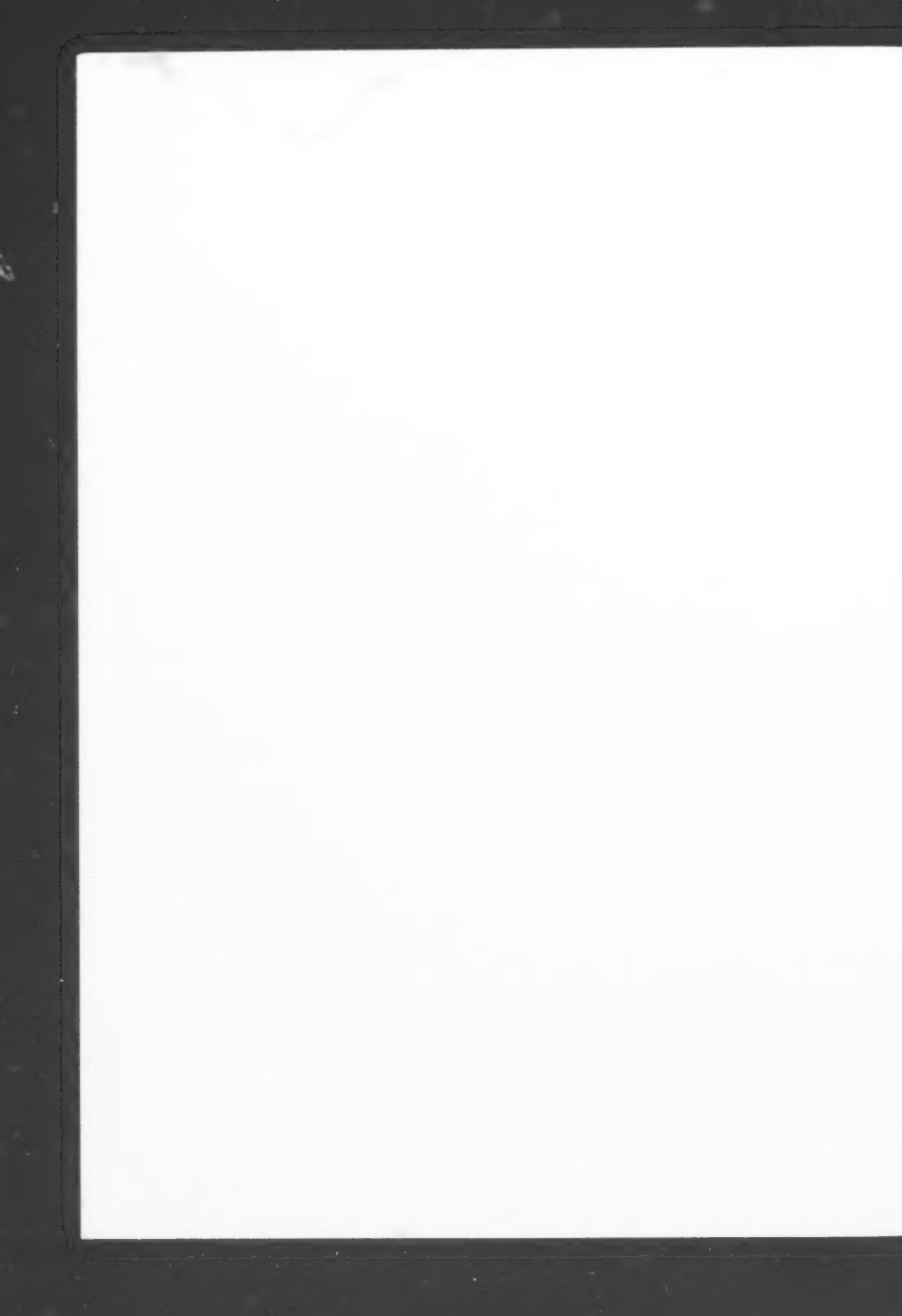
1939. "Organisms Collected from Whales in the Aleutian Islands." Murrelet. Vol. 20, pp. 67-69.

WITHERS, T. H.

1928. Catalogue of Fossil Cirripedia in the British Museum. Vol. 1, pp. 15, 36.

VICTORIA, B.C.

Printed by DON McDIARMID, Printer to the Queen's Most Excellent Majesty
1955



HANDBOOK SERIES

of the

BRITISH COLUMBIA PROVINCIAL MUSEUM
DEPARTMENT OF EDUCATION
VICTORIA, B.C.

- No. 1. Fifty Edible Plants of British Columbia.
George A. Hardy. 25 cents.
- No. 2. The Amphibians of British Columbia.
G. Clifford Carl. 50 cents.
- No. 3. The Reptiles of British Columbia.
G. Clifford Carl. 50 cents.
- No. 4. Some Mushrooms and Other Fungi of British Columbia.
George A. Hardy. 25 cents.
- No. 5. The Fresh-water Fishes of British Columbia.
G. Clifford Carl and W. A. Clemens. 50 cents.
- No. 6. The Birds of British Columbia:
(1) The Woodpeckers; (2) The Crows and Their Allies.
C. J. Guiguet and Frank L. Beebe. 50 cents.
- No. 7. The Barnacles of British Columbia.
Ira E. Cornwall. 50 cents.
-

Other publications of the Provincial Museum are:—

Annual Reports: Covering the activities of the Museum for each year.

Occasional Paper Series: Containing scientific papers in the fields of natural history and anthropology of the Province.

Anthropology in British Columbia Series: Reporting on activities in the field of anthropology for each year.

Special Publications: Containing material not included in the other series.

Copies of Museum publications may be obtained by applying to the Provincial Museum of Natural History and Anthropology, Victoria, B.C.

